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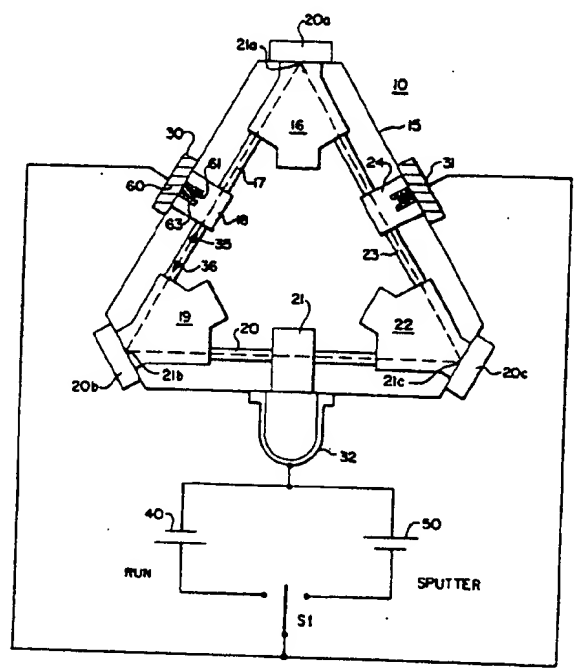
(54) Ring laser angular rate sensor.

(57) In a ring laser angular rate sensor (10) a gas discharge device formed between at least one anode (30, 31) and a cathode (32) comprises getter material (61) at the anode site. By applying a voltage between said at least one anode (30, 31) and said cathode (32) with said voltage having a polarity opposite to the operating voltage of the gas discharge device, the getter material is sputtered as a film in the gas discharge device.



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Ring Laser Angular Rate Sensor

This invention relates to a ring laser angular rate sensor according to the preamble of claim 1.

Alkaline-earth materials, commonly barium, strontium, calcium, and titanium, may be used as getters to scavenge residual contaminant gases in high vacuum devices and gas discharge devices such as lasers which contain rare earth gases such as helium and neon. Because of the extreme reactiveness of these materials with air, commercially available getter material is usually alloyed with aluminum or other materials in order to reduce their reactiveness.

In ring laser resonant cavity structures commonly employed as angular rate sensors, a mechanically thermally stable block provides a plurality of interconnected cavities which in turn provide an optical closed-loop path. The cavities are evacuated and then filled with helium and neon under low pressure. Commonly two anodes and one cathode are symmetrically positioned along the optical closed-loop path in communication with the cavity to provide a pair of ionization current paths thereby creating counter-propagating laser beams. Such devices as these usually include a getter. However, ring laser structures used as angular rate sensors are particularly sensitive to any particulate matter or residue of getter material which may be included as a step in the production of such devices.

In order to provide a getter, prior art ring laser structures and processes include a getter assembly consisting of a snap ring welded to a getter pan containing the getter material. This assembly is clamped inside the optical cavity of the ring laser structure. The getter material is flashed and the cavity closed off at its gas-filling pinch tube leaving the getter assembly inside the cavity. This system has several disadvantages. Particles are shed from the getter assembly due to shock, vibration, and/or temperature variations. This particular matter contaminates the laser and reduces the useful life thereof. Further, a certain amount of contaminated gases is emitted from the getter material just before it flashes which also reduces the life of the laser.

It is therefore the object of the present invention to provide an improved apparatus for depositing getter material in a gas discharge device without flashing the getter material. This object is achieved by the characterizing features of claim 1. Further advantageous embodiments may be taken from the sub-claims.

Briefly, this invention contemplates the provision of providing an electrode composed of, at least in part, getter material capable of being sputtered. The electrode may then provide both the function of establishing a getter film in the structure by sputtering and the function of establishing a gas discharge current by serving as an anode in normal discharge current operation.

With respect to the single figure of the attached drawing, the invention shall be further described.

The single figure illustrates a ring laser angular rate sensor apparatus 10. The assembly includes a mechanically and thermally stable block 15 such as fused quartz and the like. Block 15 provides a plurality of interconnected cavities or tunnels including cavities 16, 17, 18, 19, 20, 21, 22, 23, and 24. Cavities 17, 20, and 23 form, at least in part, a triangular shaped optical closed-loop path. At each of the corners of the block is provided a wave reflecting means which is illustrated in FIGURE 1 by means 20a, 20b, and 20c, which respectively provide wave reflecting surfaces 2la, 2lb, and 2lc. The ring laser angular rate sensor apparatus also includes a first anode 30 in communication with cavity l8 and cavity l7, a second anode 3l in communication with cavity 24 and cavity 23, and a cathode 32 in communication with cavities 2l and 20.

The apparatus as so far described is well known in the art and is specifically described in Patent 3,390,606.

Of course, all of the elements described above, including the mirrors, cathodes, and the anodes are all tightly sealed to the block so that the gas within the plurality of interconnecting cavities therein is maintained at the proper pressure and free from contamination. In order to generate counter-propagating laser beams 35 and 36 indicated by the triangular shaped dashed line, a positive potential relative to cathode 32 is applied to anodes 30 and 3l so as to produce an ionization current between the anodes and the cathode, along the shortest path, creating a plasma, and thereby generating counter-propagating laser beams in a well known manner.

A cross-section of the details of both anodes 30 and 3l, which are substantially identical, will now be described. Anode 30 comprises a head portion 60 arranged in such a manner to engage block l5 surrounding cavity l8 for sealing off the surrounding atmosphere from the gas filled cavity. Extending from head portion 60 is a stem portion 6l disposed in cavity l8. Substantially surrounding stem portion 6l is control guide 63 which may be cylindrical in shape and extends from head portion 60.

Stem portion 6l is intended to be composed of, at l ast in part, a getter material, for example, an alloy of titanium. Guiding means 63 may be anodized aluminum having a function as will be described below. Head portion 60 is adapted to have terminal means for connecting anode 30 to an electric potential source.

The switch Sl and the connections therefrom are shown for ease in understanding the invention. Switch Sl is adapted to be connected to electric potential source 40 in the run condition, and is adapted to be connected to electric potential source 50 in the sputter condition. Source 40 is arranged in such a manner so that when switch Sl is in the run condition, a positive polarity electric potential is applied to anodes 30 and 3l relative to cathode 32. On the other hand when switch Sl is in the sputter condition, source 50 is arranged in such a manner that a negative electric potential is applied to anodes 30 and 3l relative to cathode 32.

In operation, the cavities of block l5 are filled with a sputtering gas such as a HeNe mixture or the like for providing a gas discharge. The required value of potential source 50 is dependent upon the sputtering gas, the position and shape of the electrode(s), and the getter material selected. Typically, it may be in the order of lKV. When switch Sl is in the sputter condition and if source 50 is sufficiently large, the polarity is such that a stream of positive ions will bombard the stem portion 6l composed of some getter material Atoms of the getter material are then ejected in various directions leaving the stem portion surface in an abraded and roughened condition. The ejected atoms cling firmly to the inner cavity walls forming a uniform getter film thereon. Since the block is usually made of a silica based material, a getter film is enhanced. In a practical embodiment, switch Sl is only in the sputter condition for a sufficient length of time to provide an appropriate amount of a getter film on the inner cavity walls. Upon completion of the sputtering process, the sputtering gas may be removed from the block cavities, and refilled with an appropriate mixture of helium neon normally associated with ring laser operations.

When switch Sl is in a run condition, the positive potential is applied to the anodes 30 and 3l relative to cathode 32, and the sputtering process is not obtained in the run condition since it is no longer attacked by positive ions since they are directed toward the cathode 32. Furthermore, the potential of source 40 in normal laser operation is much less than that required for sputtering. Therefor , in the run condition, no sputt ring takes place and no further degradation of the getter material anode stem portion 6l occurs.

The sputtering guide 63 surrounding the getter material stem portion 6l is provided so that only selected surfaces of the stem portion are sputtered to control the amount of degradation of the getter material as well as focus the sputtering away toward cavity l7.

It is within the scope of this invention, that a wide choice of selected materials may be used for the getter material stem portion 6l. Depending upon the appropriate alloy selected for stem portion 6l, the sputtering guide 63 may not be required. Further, the head portion as well as the stem portion may be composed of a single body getter material alloy.

Claims

1. A ring laser angular rate sensor comprising: a mechanically thermally stable block (15) for providing a cavity (17, 20, 23) defined substantially by inner wall portions for containing a primary gas and potentially including gas contaminants, said cavity including a plurality of interconnected cavity portions providing a closed-loop path; and

at least a first anode (30) and a cathode (32), in communication with said cavity and said gas therein, with said first anode and said cathode adapted to be connected in the operate condition, to an electrical potential source for passage of electrical current therebetween through said gas and of sufficient magnitude to produce a pair of counter-propagating laser beams along said closed-loop path, **characterized in that** said anode (30 or 31) is composed of at least in part a getter material (61).

2. A sensor according to claim 1, **characterized in that** said getter material (61) is selected from the alkaline-earth group.

3. Sensor according to claim l, **characterized in that** said getter material (61) is selected from a group consisting of strontium, barium, titanium, and calcium.

4. Sensor according to claim 1, **characterized in that** said first anode (30 or 31) and said cathode (32) are adapted to be connected to an electrical potential source (50) of polarity and sufficient magnitude to sputter said getter material (61) onto portions of said cavity inner wall portions.

5. Sensor according to one of claims 1 to 4, **characterized in that** said first anode (30, 31) includes:

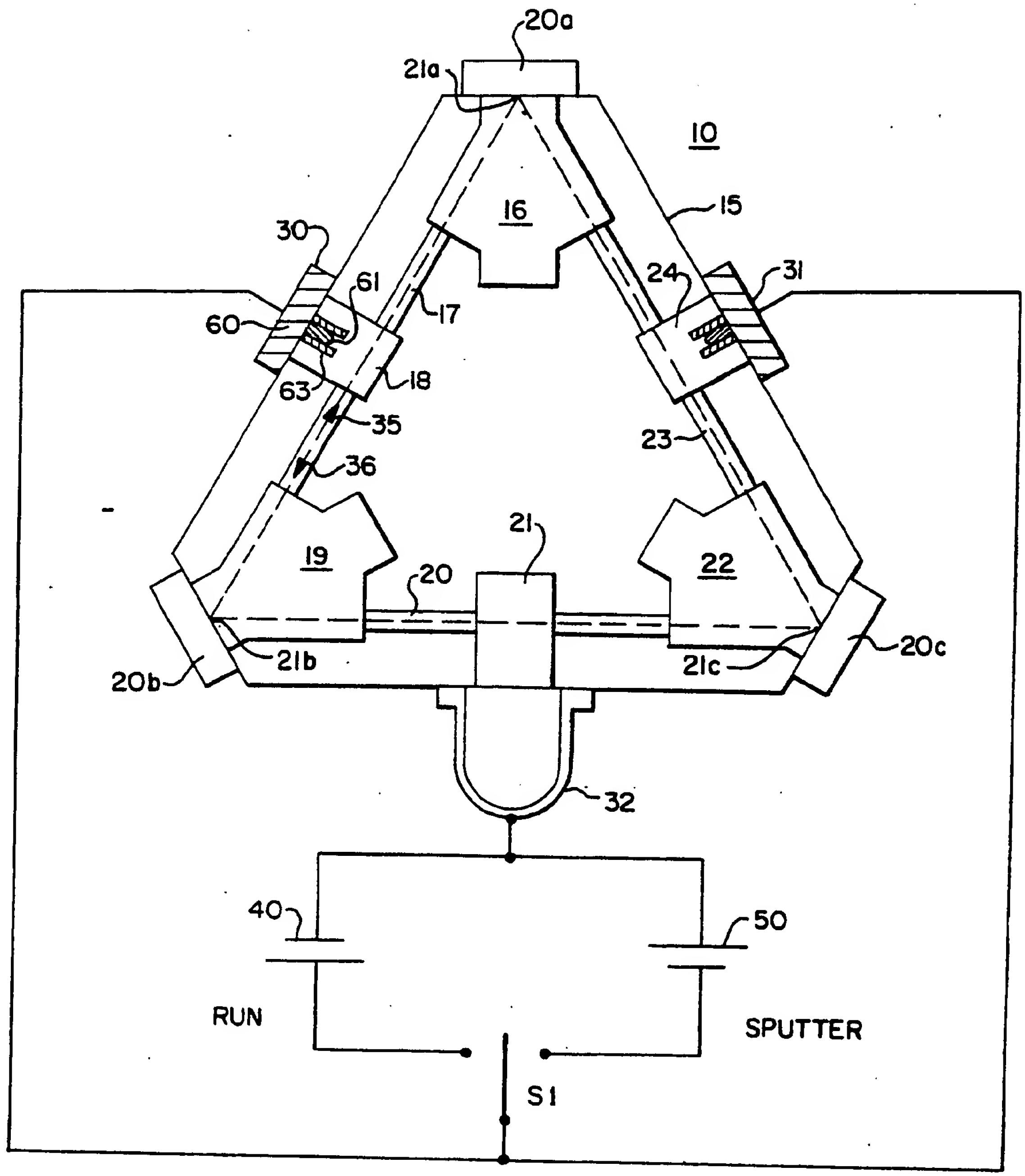
a head portion (60) capable of providing a seal between said block (15) and a selected cavity portion (17, 18) of said cavity; and

a stem portion (61) fixed to said head portion and

extending into a portion of said cavity, said stem portion being compos d of, at least in part, said getter material.

6. Sensor according to claim 5, **characterized by** a control guide (63) surrounding said stem portion (6l) and consisting of anodized aluminum.

7. Sensor according to claim 5, **characterized by** a voltage supply means comprising two voltage sources (40, 50) of diff rent polarity in parallel between said first anode (30, 3l) and said cathode - (32) and a switch for alternatively connecting one of said voltage sources to said cathode/anode path in a sputtering or run mode, respectively.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S1